CLAIMS

1. An optical element, comprising:

a substrate in which grooves are formed;

wherein the expression:

$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$

is satisfied, where n is the refractive index of the substrate at a wavelength of 400 nm, and d (nm) is a depth per step of the grooves; and

wherein the grooves are formed in two steps of depth d and depth 2d.

2. An optical element, comprising:

a substrate in which grooves are formed;

wherein the expression:

$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$

is satisfied, where n is a refractive index of the substrate at a wavelength of 400 nm, and d (nm) is a depth per step of the grooves; and

wherein the grooves are formed in four steps of depth d, depth 2d, depth 3d and depth 4d.

3. The optical head according to claim 2,

wherein the depth of the grooves is lined up in the order: depth 2d, depth 4d, depth d, depth 3d, or in the order: depth 3d, depth d, depth 4d, depth 2d.

4. The optical element according to claim 1 or 2,

wherein the grooves are formed in concentric ring-shapes.

5. The optical element according to claim 1 or 2,

wherein the grooves are adjacent via a portion in which no grooves are formed, and the width of each step of the grooves is substantially the same as the width of the portion in which no grooves are formed.

6. An optical head, comprising:

a first light source that emits light of a first wavelength that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength that at least either records onto or reproduces information from a second information recording medium;

focusing means for focusing light that is emitted from the first light source and from the second light source;

an optical element that passes light of the first wavelength and diffracts light of the second wavelength; and

photodetecting means for detecting light of the first wavelength and light of the second wavelength;

wherein light of the first wavelength and light of the second wavelength pass through the optical element, after which they are focused by the focusing means and are irradiated onto the information recording media;

wherein the optical element is an optical element in which grooves are formed in a substrate;

wherein the expression:

$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$

is satisfied, where n is a refractive index of the substrate at a wavelength of 400 nm, and d (nm) is a depth per step of the grooves;

wherein the grooves are formed in two steps of depth d and depth 2d; and

wherein the photodetecting means detects light that is at least either reflected or diffracted by the information recording media.

7. An optical head, comprising:

a first light source that emits light of a first wavelength, that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength, that at least either records onto or reproduces information from a second information recording medium;

focusing means for focusing light that is emitted from the first light source and from the second light source;

an optical element that passes light of the first wavelength and diffracts light of the second wavelength; and

photodetecting means for detecting light of the first wavelength and light of the second wavelength;

wherein light of the first wavelength and light of the second wavelength pass through the optical element, after which they are focused by the focusing means and are irradiated onto the information recording media;

wherein the optical element is an optical element in which grooves are formed in a substrate;

wherein the expression:

$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$

is satisfied, where n is a refractive index of the substrate at a wavelength of 400 nm, and d (nm) is a depth per step of the grooves;

wherein the grooves are formed in four steps of depth d, depth 2d, depth 3d and depth 4d; and

wherein the photodetecting means detects light that is at least either reflected or diffracted by the information recording media.

8. The optical head according to claim 7,

wherein the depth of the grooves is lined up in the order: depth 2d, depth 4d, depth d, depth 3d, or in the order depth 3d, depth d, depth 4d, depth 2d.

9. The optical head according to claim 6 or 7,

wherein the second wavelength is 1.5 to 1.8 times the length of the first wavelength.

10. The optical head according to claim 6 or 7,

wherein the grooves of the optical element are formed on a face that is close to the focusing means.

11. The optical head according to claim 6 or 7,

wherein for light of the second wavelength that is diffracted by the optical element, the light that diverges is stronger than the light that converges with respect to incident light.

12. The optical head according to claim 6 or 7,

wherein the optical element corrects the aberration to not more than 70 mλ when light of the second wavelength that is diffracted by the optical element is focused on an information surface of a second

information recording medium.

13. An optical head comprising:

a first light source that emits light of a first wavelength, that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength, that at least either records onto or reproduces information from a second information recording medium;

a third light source that emits light of a third wavelength, that at least either records onto or reproduces information from a third information recording medium;

focusing means for focusing light that is emitted from the first light source, from the second light source and from the third light source;

a first optical element that passes light of the first wavelength and diffracts light of the second wavelength and light of the third wavelength; and

photodetecting means for detecting light of the first wavelength, light of the second wavelength and light of the third wavelength;

wherein light of the first wavelength, light of the second wavelength and light of the third wavelength pass through the optical element, after which they are focused by the focusing means and are irradiated onto the information recording media;

wherein the first optical element is an optical element in which grooves are formed in a substrate;

wherein the expression:

$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$

is satisfied, where n is a refractive index of the substrate at a wavelength of 400 nm, and d (nm) is a depth per step of the grooves;

wherein the grooves are formed in two steps of depth d and depth 2d; and

wherein the photodetecting means detects light that is at least either reflected or diffracted by the information recording media.

14. An optical head, comprising:

a first light source that emits light of a first wavelength, that at least either records onto or reproduces information from a first

information recording medium;

a second light source that emits light of a second wavelength, that at least either records onto or reproduces information from a second information recording medium;

a third light source that emits light of a third wavelength, that at least either records onto or reproduces information from a third information recording medium;

focusing means for focusing light that is emitted from the first light source, from the second light source and from the third light source;

a first optical element that passes light of the first wavelength and diffracts light of the second wavelength and the third wavelength; and

photodetecting means for detecting light of the first wavelength, light of the second wavelength and light of the third wavelength;

wherein light of the first wavelength, light of the second wavelength and light of the third wavelength pass through the optical element, after which they are focused by the focusing means and are irradiated onto the information recording media;

wherein the first optical element is an optical element in which grooves are formed in a substrate;

wherein the expression:

$$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$$

is satisfied, where n is a refractive index of the substrate at a wavelength of 400 nm, and d (nm) is a depth per step of the grooves;

wherein the grooves are formed in four steps of depth d, depth 2d, depth 3d and depth 4d; and

wherein the photodetecting means detects light that is at least either reflected or diffracted by the information recording media.

15. The optical head according to claim 14,

wherein the depth of the grooves is lined up in the order: depth 2d, depth 4d, depth d, depth 3d, or in the order depth 3d, depth d, depth 4d, depth 2d.

16. The optical head according to claim 13 or 14,

wherein the second wavelength is 1.5 to 1.8 times the length of the first wavelength; and

wherein the third wavelength is 1.8 to 2.2 times the length of the first wavelength.

17. The optical head according to claim 13 or 14,

wherein, when a first region is a substantially circle-shaped region in the central vicinity of the first optical element, a second region is a substantially ring-shaped region that surrounds the first region, and a third region is a region on the outside of the second region,

light of the first wavelength passes through the first, second and third region, light of the second wavelength passes through the first and second region, and light of the third wavelength passes through the first region.

18. The optical head according to claim 13 or 14,

wherein for light of the second wavelength and third wavelength that are diffracted by the first optical element, the light that diverges is stronger than the light that converges with respect to incident light.

19. The optical head according to claim 13 or 14, further comprising:

phase correcting means for correcting the aberration of light of the second wavelength that is diffracted by the first optical element to not more than 70 mλ when light of the second wavelength is focused on the information surface of the second information recording medium, and

for correcting the aberration of light of the third wavelength that is diffracted by the first optical element to not more than 70 mλ when light of the third wavelength is focused on the information surface of the third information recording medium;

wherein the phase correcting means does not change the phase of light of the first wavelength; and

wherein the phase correcting means is provided in the light path between the light sources and the optical information recording medium.

20. The optical head according to claim 13 or 14, further comprising:

a second optical element that passes light of the first wavelength and light of the third wavelength, and diffracts light of the second wavelength;

wherein light of the first wavelength, light of the second

wavelength and light of the third wavelength pass through the two optical elements, after which they are focused by the focusing means, and irradiated onto the optical information recording medium.

21. The optical head according to claim 13 or 14, further comprising:

a second optical element that passes light of the first wavelength and light of the third wavelength, and diffracts light of the second wavelength;

wherein light of the first wavelength, light of the second wavelength and light of the third wavelength pass through the two optical elements, after which they are focused by the focusing means, and irradiated onto the optical information recording medium;

wherein the second optical element is an optical element in which grooves are formed in a substrate;

wherein the expression:

$760 \text{ nm} \leq (n - 1) \times d \leq 840 \text{ nm}$

is satisfied, where n is a refractive index of the substrate at a wavelength of 400 nm, and d (nm) is a depth per step of the grooves; and

wherein the grooves are formed in two steps of depth d and depth 2d.

22. The optical head according to claim 13 or 14, further comprising:

a second optical element that passes light of the first wavelength and light of the third wavelength, and diffracts light of the second wavelength;

wherein light of the first wavelength, light of the second wavelength and light of the third wavelength pass through the two optical elements, after which they are focused by the focusing means, and irradiated onto the optical information recording medium;

wherein the second optical element is an optical element in which grooves are formed in a substrate;

wherein the expression:

$760 \text{ nm} \leq (n - 1) \times d \leq 840 \text{ nm}$

is satisfied, where n is a refractive index of the substrate at a wavelength of 400 nm, and d (nm) is a depth per step of the grooves; and

wherein the grooves are formed in three steps of depth d, depth 2d and depth 3d.

23. The optical head according to claim 13 or 14, further comprising:

a second optical element that passes light of the first wavelength and light of the third wavelength, and diffracts light of the second wavelength;

wherein light of the first wavelength, light of the second wavelength and light of the third wavelength pass through the two optical elements, after which they are focused by the focusing means, and irradiated onto the optical information recording medium; and

wherein the first optical element and the second optical element are formed on a top and a rear of a single substrate.

24. The optical head according to claim 13 or 14, further comprising:

a second optical element that passes light of the first wavelength and light of the third wavelength, and diffracts light of the second wavelength;

wherein light of the first wavelength, light of the second wavelength and light of the third wavelength pass through the two optical elements, after which they are focused by the focusing means, and irradiated onto the optical information recording medium; and

wherein the first optical element and the second optical element are formed on a top and a rear of a single substrate, and the face on which the second optical element is formed, of the two faces of the single substrate, is closer to the focusing means.

25. The optical head according to claim 13 or 14, further comprising:

a second optical element that passes light of the first wavelength and light of the third wavelength, and diffracts light of the second wavelength;

wherein light of the first wavelength, light of the second wavelength and light of the third wavelength pass through the two optical elements, after which they are focused by the focusing means, and irradiated onto the optical information recording medium; and

wherein the first and second optical elements correct the aberration of light of the second wavelength that is diffracted by the first and second optical elements to not more than 70 mλ when that light is focused onto the information surface of the second information recording

medium; and

correct the aberration of light of the third wavelength that is diffracted by the first optical element to not more than 70 mλ when that light is focused on the information surface of the third information recording medium.

26. The optical head according to claim 13 or 14,

wherein, when a distance between the surface of the first information recording medium on the focusing means side and the tip of the focusing means on the side of the first information recording medium is WD1 when light of the first wavelength is irradiated onto the first information recording medium, and

a distance between the surface of the second information recording medium on the focusing means side and the tip of the focusing means on the side of the second information recording medium is WD2 when light of the second wavelength is irradiated onto the second information recording medium, and

a distance between the surface of the third information recording medium on the focusing means side and the tip of the focusing means on the side of the third information recording medium is WD3 when light of the third wavelength is irradiated onto the third information recording medium,

a difference between the maximum value and the minimum value of WD1, WD2 and WD3 is smaller than the maximum value of the diameter of the focusing means.

27. The optical head according to claim 13 or 14,

wherein, when a distance between the surface of the first information recording medium on the focusing means side and the tip of the focusing means on the side of the first information recording medium is WD1 when light of the first wavelength is irradiated onto the first information recording medium, and

a distance between the surface of the second information recording medium on the focusing means side and the tip of the focusing means on the side of the second information recording medium is WD2 when light of the second wavelength is irradiated onto the second information recording medium, and

a distance between the surface of the third information recording medium on the focusing means side and the tip of the focusing means on the side of the third information recording medium is WD3 when light of the third wavelength is irradiated onto the third information recording medium,

WD1, WD2 and WD3 are substantially equivalent.

28. The optical head according to claim 6, 7, 13 or 14, further comprising:

a converter for converting a plurality of signals, which are received in parallel and are output from the photodetecting means into a serial signal.

29. The optical head according to claim 6, 7, 13 or 14, further comprising:

a converter for converting a plurality of signals, which are received in parallel and are output from the photodetecting means, into a serial signal;

wherein the serial signal is an electrical signal.

30. The optical head according to claim 6, 7, 13 or 14, further comprising:

a first converter for converting a plurality of signals, which are output from the photodetecting means and received in parallel, into a serial signal; and

a second converter for receiving the electric signal that is output from the first converter and for converting the electric signal into an optical signal.

31. An optical information recording and reproduction apparatus, comprising:

an optical head that includes;

a first light source that emits light of a first wavelength, that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength, that at least either records onto or reproduces information from a second

information recording medium;

focusing means for focusing light that is emitted from the first light source and from the second light source;

an optical element that passes light of the first wavelength and diffracts light of the second wavelength; and

photodetecting means for detecting light of the first wavelength and light of the second wavelength,

further comprising:

moving means for moving the information recording medium and the optical head relative to each other;

wherein light of the first wavelength and light of the second wavelength pass through the optical element, after which they are focused by the focusing means and are irradiated onto the information recording media;

wherein the optical element is an optical element in which grooves are formed in a substrate;

wherein the expression:

$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$

is satisfied, where n is a refractive index of the substrate at a wavelength of 400 nm, and d (nm) is a depth per step of the grooves;

wherein the grooves are formed in two steps of depth d and depth 2d; and

wherein the photodetecting means detects light that is at least either reflected or diffracted by the information recording media.

32. An optical information recording and reproduction apparatus, comprising:

an optical head that includes;

a first light source that emits light of a first wavelength, that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength, that at least either records onto or reproduces information from a second information recording medium;

focusing means for focusing light that is emitted from the first light source and from the second light source;

an optical element that passes light of the first wavelength and

diffracts light of the second wavelength; and

photodetecting means for detecting light of the first wavelength and light of the second wavelength,

further comprising:

moving means for moving the information recording medium and the optical head relative to each other;

wherein light of the first wavelength and light of the second wavelength pass through the optical element, after which they are focused by the focusing means and are irradiated onto the information recording media;

wherein the optical element is an optical element in which grooves are formed in a substrate;

wherein the expression:

$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$

is satisfied, where n is a refractive index of the substrate at a wavelength of 400 nm, and d (nm) is a depth per step of the grooves;

wherein the grooves are formed in four steps of depth d, depth 2d, depth 3d and depth 4d; and

wherein the photodetecting means detects light that is at least either reflected or diffracted by the information recording media.

33. The optical information recording and reproduction apparatus according to claim 32,

wherein the grooves are lined up in the order: depth 2d, depth 4d, depth d, depth 3d, or in the order depth 3d, depth d, depth 4d, depth 2d.

34. An optical information recording and reproduction apparatus, comprising:

an optical head that includes;

a first light source that emits light of a first wavelength, that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength, that at least either records onto or reproduces information from a second information recording medium;

a third light source that emits light of a third wavelength, that at least either records onto or reproduces information from a third

information recording medium;

focusing means for focusing light that is emitted from the first light source, from the second light source and from the third light source;

a first optical element that passes light of the first wavelength and diffracts light of the second wavelength and light of the third wavelength; and

photodetecting means for detecting light of the first wavelength, light of the second wavelength and light of the third wavelength;

further comprising:

moving means for moving the information recording medium and the optical head relative to each other;

wherein light of the first wavelength, light of the second wavelength and light of the third wavelength pass through the optical element, after which they are focused by the focusing means and are irradiated onto the information recording media;

wherein the first optical element is an optical element in which grooves are formed in a substrate;

wherein the expression:

$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$

is satisfied, where n is a refractive index of the substrate at a wavelength of 400 nm, and d (nm) is a depth per step of the grooves;

wherein the grooves are formed in two steps of depth d and depth 2d; and

wherein the photodetecting means detects light that is at least either reflected or diffracted by the information recording media.

35. An optical information recording and reproduction apparatus, comprising:

an optical head that includes;

a first light source that emits light of a first wavelength, that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength, that at least either records onto or reproduces information from a second information recording medium;

a third light source that emits light of a third wavelength, that at least either records onto or reproduces information from a third

information recording medium;

focusing means for focusing light that is emitted from the first light source, from the second light source and from the third light source;

a first optical element that passes light of the first wavelength and diffracts light of the second wavelength and light of the third wavelength; and

photodetecting means for detecting light of the first wavelength, light of the second wavelength and light of the third wavelength;

further comprising:

moving means for moving the information recording medium and the optical head relative to each other;

wherein light of the first wavelength, light of the second wavelength and light of the third wavelength pass through the optical element, after which they are focused by the focusing means and are irradiated onto the information recording media;

wherein the first optical element is an optical element in which grooves are formed in a substrate;

wherein the expression:

$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$

is satisfied, where n is a refractive index of the substrate at a wavelength of 400 nm, and d (nm) is a depth per step of the grooves;

wherein the grooves are formed in four steps of depth d, depth 2d, depth 3d and depth 4d; and

wherein the photodetecting means detects light that is at least either reflected or diffracted by the information recording media.

36. The optical information recording and reproduction apparatus according to claim 34 and 35, further comprising:

a second optical element that passes light of the first wavelength and light of the third wavelength, and diffracts light of the second wavelength;

wherein light of the first wavelength, light of the second wavelength and light of the third wavelength pass through the two optical elements, after which they are focused by the focusing means, and irradiated onto the optical information recording medium.

37. An optical element, comprising:

a substrate, in which steps are formed protruding from a flat surface thereof;

wherein the expression:

$760 \text{ nm} \leq (n - 1) \times d \leq 840 \text{ nm}$

is satisfied when a refractive index of the substrate at a wavelength of 400 nm is n, and a height (nm) of one step is d; and

wherein the height of the steps is an integer multiple of d.

38. The optical element according to claim 37,

wherein the steps are formed in concentric ring-shapes.

39. An optical head, comprising:

a first light source that emits light of a first wavelength that is in a range of 380 nm to 420 nm and that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength, that at least either records onto or reproduces information from a second information recording medium;

an optical element that passes light of the first wavelength, and converts the phase of light of the second wavelength;

focusing means for focusing light of the first wavelength and light of the second wavelength onto the information recording medium;

detecting means for detecting light of the first wavelength and light of the second wavelength;

wherein the optical element is an optical element comprising a substrate, in which steps are formed protruding from a flat surface thereof; and

wherein the expression:

$760 \text{ nm} \leq (n - 1) \times d \leq 840 \text{ nm}$

is satisfied when a refractive index of the substrate at a wavelength of 400 nm is n, and a height (nm) of one step is d.

40. An optical head, comprising:

a first light source that emits light of a first wavelength that is in a range of 380 nm to 420 nm and that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength,

that at least either records onto or reproduces information from a second information recording medium;

an optical element that passes light of the first wavelength, and converts the phase of light of the second wavelength;

focusing means for focusing light of the first wavelength and light of the second wavelength onto the information recording medium; and

detecting means for detecting light of the first wavelength and light of the second wavelength;

wherein the position of the second light source is set closer to the focusing means than a position at which the aberration at the information recording surface of the second information recording medium, when the optical element is not present, is at a minimum;

wherein the optical element is an optical element comprising a substrate, in which steps are formed protruding from a flat surface thereof; and

wherein the expression:

$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$

is satisfied when a refractive index of the substrate at a wavelength of 400 nm is n, and a height (nm) of one step is d.

41. An optical head, comprising:

a first light source that emits light of a first wavelength that is in a range of 380 nm to 420 nm and that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength, that at least either records onto or reproduces information from a second information recording medium;

an optical element that passes light of the first wavelength, and converts the phase of light of the second wavelength;

focusing means for focusing light of the first wavelength and light of the second wavelength onto the information recording medium; and

detecting means for detecting light of the first wavelength and light of the second wavelength;

wherein the position of the second light source is set further from the focusing means than a position that is substantially midway between the position of that light source at which the aberration at the information recording surface of the second information recording

medium when the optical element is not present is at a minimum, and the position of that light source at which light of the second wavelength that is incident on the focusing means is collimated light;

wherein the optical element is an optical element comprising a substrate, in which steps are formed protruding from a flat surface thereof; and

wherein the expression:

$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$

is satisfied when a refractive index of the substrate at a wavelength of 400 nm is n, and a height (nm) of one step is d.

42. The optical head according to claim 39, 40 or 41, further comprising:

tilting means for tilting the focusing means.

43. An optical head comprising:

a first light source that emits light of a first wavelength that is in a range of 380 nm to 420 nm and that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength, that at least either records onto or reproduces information from a second information recording medium;

an optical element that passes light of the first wavelength, and converts the phase of light of the second wavelength;

focusing means for focusing light of the first wavelength and light of the second wavelength onto the information recording medium; and

detecting means for detecting light of the first wavelength and light of the second wavelength;

wherein light of the second wavelength that is incident on the focusing means is collimated light;

wherein the optical element is an optical element comprising a substrate, in which steps are formed protruding from a flat surface thereof; and

wherein the expression:

$380 \text{ nm} \leq (n - 1) \times d \leq 420 \text{ nm}$

is satisfied when a refractive index of the substrate at a wavelength of 400 nm is n, and a height (nm) of one step is d.

44. The optical head according to claim 39, 40, 41 or 43,

wherein the optical element corrects the aberration to not more than 70 mλ when light of the second wavelength is focused on the information recording surface of the second information recording media.

45. An optical head, comprising:

a first light source that emits light of a first wavelength that is in a range of 380 nm to 420 nm and that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength, that at least either records onto or reproduces information from a second information recording medium;

a third light source that emits light of a third wavelength, that at least either records onto or reproduces information from a third information recording medium;

an optical element that passes light of the first wavelength and light of the third wavelength, and converts the phase of light of the second wavelength;

focusing means for focusing light of the first wavelength, light of the second wavelength and light of the third wavelength onto the information recording medium; and

detecting means for detecting light of the first wavelength, light of the second wavelength and light of the third wavelength;

wherein the optical element is an optical element comprising a substrate, in which steps are formed protruding from a flat surface thereof; and

wherein the expressions:

$760 \text{ nm} \leq (n1 - 1) \times d \leq 840 \text{ nm}$

and

$-10 \text{ nm} < \lambda 1 / (n1 - 1) \cdot \lambda 3 / (n3 - 1) / 2 < 10 \text{ nm}.$

are satisfied when a refractive index of the optical element at the wavelength of 400nm is n, the third wavelength is λ3 (nm), a refractive index of the optical element at the wavelength λ3 is n3, and a height (nm) of one step is d.

46. An optical head, comprising:

a first light source that emits light of a first wavelength that is in a range of 380 nm to 420 nm and that at least either records onto or reproduces information from a first information recording medium;

a second light source that emits light of a second wavelength, that at least either records onto or reproduces information from a second information recording medium;

a third light source that emits light of a third wavelength, that at least either records onto or reproduces information from a third information recording medium;

an optical element that passes light of the first wavelength and light of the third wavelength, and changes the phase of light of the second wavelength;

a liquid crystal element that passes light of the first wavelength and light of the second wavelength, and diffracts light of the third wavelength;

focusing means for focusing light of the first wavelength, light of the second wavelength and light of the third wavelength onto the information recording medium; and

detecting means for detecting light of the first wavelength, light of the second wavelength and light of the third wavelength;

wherein the optical element is an optical element comprising a substrate, in which steps are formed protruding from a flat surface thereof;

wherein the expression:

$$700 \text{ nm} \leq (n - 1) \times d \leq 840 \text{ nm}$$

is satisfied when a refractive index of the substrate at a wavelength of 400 nm is n, and a height (nm) of one step is d; and

wherein the liquid crystal element comprises:

a substrate that has a relief-shaped hologram pattern;

a first transparent electrode, which is formed on the relief-shaped hologram pattern; and

a second transparent electrode that is arranged opposite the first transparent electrode to sandwich the liquid crystal;

wherein the liquid crystal element passes light of the first wavelength and light of the second wavelength, and diffracts light of the third wavelength by controlling a voltage that is applied to the first transparent electrode and the second transparent electrode.

47. An optical information recording and reproduction apparatus, comprising:

an optical head according to claim 39, 40, 41, 43, 45 or 46; and

moving means for moving the information recording media and the optical head relative to each other.

48. A computer, comprising:

an optical information recording and reproduction apparatus that includes an optical head according to claim 6, 7, 13, 14, 39, 40, 41, 43, 45 or 46,

as an external storage device.

49. An image recording device, comprising:

an optical information recording and reproduction apparatus that includes an optical head according to claim 6, 7, 13, 14, 39, 40, 41, 43, 45 or 46;

which can at least record images from among recording images onto and reproducing images from an information recording medium.

50. An image reproduction device, comprising:

an optical information recording and reproduction apparatus that includes an optical head according to claim 6, 7, 13, 14, 39, 40, 41, 43, 45 or 46;

wherein it specializes in reproducing images from an information recording medium.

51. A server, comprising:

an optical information recording and reproduction apparatus that includes an optical head according to claim 6, 7, 13, 14, 39, 40, 41, 43, 45 or 46, as an external storage device.

52. A car navigation system, comprising:

an optical information recording and reproduction apparatus that includes an optical head according to claim 6, 7, 13, 14, 39, 40, 41, 43, 45 or 46, as an external storage device.